FATE OF NITROGEN APPLIED TO TURF USING LARGE LYSIMETERS

E. D. Miltner and B. E. Branham
Department of Crop and Soil Sciences
Michigan State University, East Lansing, MI

Four intact soil monolith lysimeters have been installed at the Hancock Turfgrass Research Center for the purpose of tracing the fate of fertilizers and pesticides applied to turf. Two of the lysimeters were installed between September 1989 and May 1990 and two during the summer of 1991. The cylindrical lysimeters were 48 inches (120cm) in depth and 45 inches (114 cm) in diameter, resulting in a surface area of $1m^2$ of turf. Construction procedures involved hand excavation around intact columns of soil in the field, followed by enclosure of this soil with the open ended stainless steel lysimeter containers, accomplished by applying downward pressure to the containers with a backhoe, pushing the containers down around the soil column. The bottoms of the enclosed cores were supported while the cores were placed back down in the ground on manhole structures which allowed access for leachate collection. Sixty four microplots constructed of PVC pipe [8 inches (20 cm) in diameter and 24 inches (60 cm) in depth] were installed adjacent to the lysimeters by pressing them into the ground using a hydraulic cylinder. These microplots received the same experimental treatments as the lysimeters and were used for destructive soil sampling and clipping collection, because lysimeters were designed for collecting leachate only. The area was established with a sod blend of three cultivars of Kentucky bluegrass (*Poa pratensis*) in August 1990. Recommended fertility practices were followed for establishment. The microplots and lysimeters installed during 1991 were established with the existing sod in place, without disturbing the root system which had already been established.

In April of 1991 an experiment was initiated to assess the fate of nitrogen fertilizer applied to turfgrass. The objective was to examine the transformations of nitrogen applied as urea. There are several pools in which the N may exist, namely plant uptake, inorganic soil N, non-living organic soil N, N present in microbial biomass, N lost to the atmosphere through volatilization or denitrification, and N leached through the profile. In addition, two nitrogen fertility schedules were compared, one which included an early Spring application and no late fall application (referred to as "Spring"), and the other containing a late fall application but none in early spring (referred to as "Fall"). Both treatments were comprised of five applications at 0.8 lb. N/1000 sq. ft. (39.5 kg N/ha) for a total of 4.0 lb. N/1000 sq. ft. (198 kg N/ha) per year. The fertility schedule is shown in Table 1.

Table 1. Nitrogen fertility schedule for HTRC lysimeters for Spring and Fall N treatments.

SPRING	FALL
April 26	
June 4	June 4
July 12	July 12
August 19	August 19
September 27	September 27
	November 8

In order to be able to distinguish the N which was applied on the two distinct dates (April 26 and November 8) from the remaining applied N, this urea was labelled with ^{15}N, a stable isotope of nitrogen. The N in this compound has an atomic weight of 15 atomic mass units, while the remainder of the N has an atomic weight of 14. This difference allows for the two to be distinguished through use of a mass spectrometer. Each treatment was applied to two lysimeters and thirty two microplots on the indicated dates. Approximately eighteen days following selected fertilizer applications, soil samples were taken by digging up four microplots of each treatment. The sixty four microplots provided for eight soil sampling dates with four replicates of each treatment at each date. Soil sampling dates were May 14, June 21, October 16, and November 26 in 1991. Results for soil samples 1 and 4 only were prepared for presentation here. Throughout the season, leachate samples were collected for analysis from the lysimeters whenever leachate accumulated at an adequate volume.

Data presented here have not yet been statistically analyzed. Therefore, it is not yet possible to draw conclusions concerning differences between the two fertilization schedules. Table 2 shows the total inorganic N (nitrate and ammonium) extracted from soil for the May 14 sampling date. Note that the Fall treatment had not yet had N fertilizer applied to it as of this date.

Table 2. Total inorganic nitrogen in soil for Spring and Fall treatments, sampled May 14, 1991. (Mean of four replications).

	TOTAL INORGANIC NITROGEN ug/g SOIL	
DEPTH (cm)	SPRING	FALL
0 - 5	17.7	14.2
5 - 10	12.4	8.0
10 - 20	5.2	6.7
20 - 40	2.0	2.4
40 - 60	1.6	1.7

As might be expected, there appears to be more N in the soil in the Spring treatment, which has been fertilized, as compared to the Fall treatment, which has not. This effect is confined to the upper two depths. Table 3 shows N levels in the soil at the fourth sampling date (November 26).

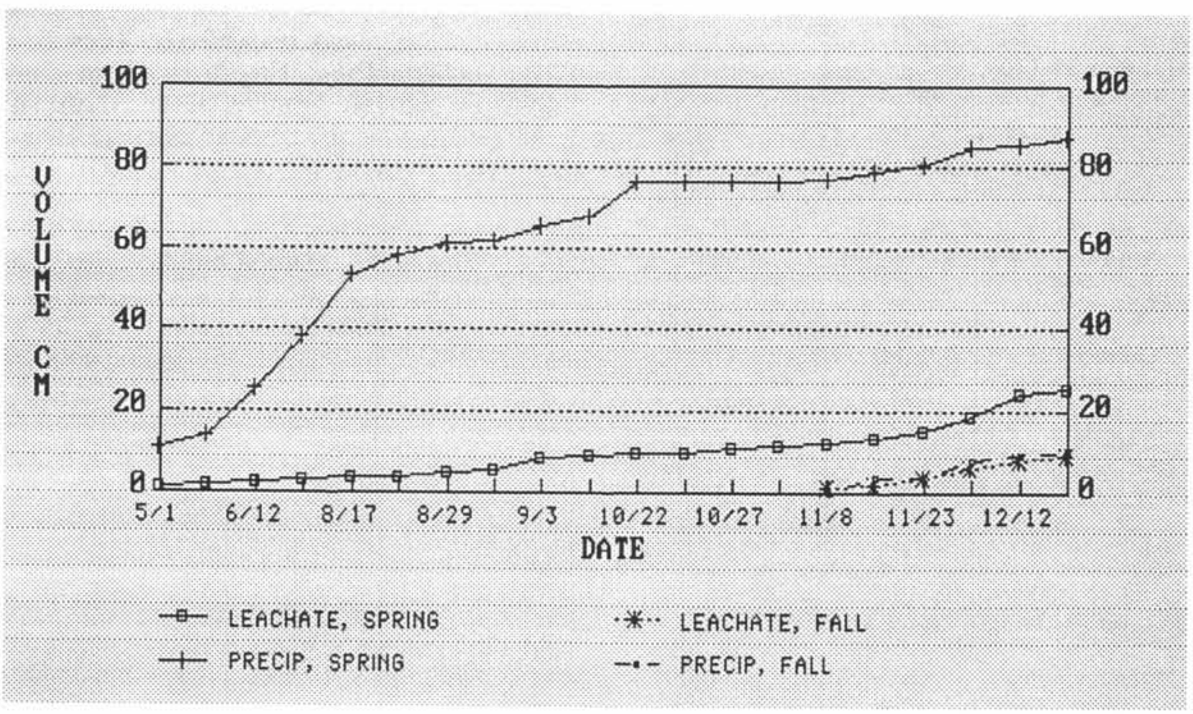
Table 3. Total inorganic nitrogen in soil for Spring and Fall treatments, sampled November 26, 1991. (Mean of two replications).

	TOTAL INORGANIC NITROGEN ug/g SOIL	
DEPTH (cm)	SPRING	FALL
0 - 5	19.1	18.5
5 - 10	10.2	7.9
10 - 20	7.2	6.1
20 - 40	3.5	2.6
40 - 60	2.3	2.4

As of this sampling date, both treatments had received 4.0 lb. N/M over the season. The Spring treatment had last been fertilized on September 27, and the Fall treatment on November 8. These data represent only two of four replications. This may explain why N levels in the Spring treatment appear higher than in the Fall treatment. This also could be due to increased N mobilization in the Spring treatment, but biomass and organic N data have not yet been completely analyzed, so it is difficult to make these assumptions. It appears that overall N levels in the soil may be increasing, especially for the Spring treatment, but again because of the absence of statistical analysis it is impossible to say if this effect is real.

Figure 1 shows the cumulative amounts of precipitation and leachate for the growing season for the lysimeters receiving the Spring treatment (upper two curves) and the Fall treatment (lower curves). The Fall precipitation curve is based on the same data as the Spring precipitation curve, except that it only includes that which occurred on or after November 8, the day of Fall treatment application.

Figure 1. Cumulative precipitation and leachate for lysimeters receiving Spring and Fall fertilization treatments.



For lysimeters that received the Spring treatment, precipitation appeared to be much greater than the volume of leachate. This was most likely due to evapotranspiration rates during the growing season. Plant water use and evaporation from the soil surface precluded much water from moving downward through the soil profile. However, for the Fall treatment, leachate amounts were very close to the amount of precipitation. This was probably due to slower growth resulting in lower evapotranspiration. Inspection of the curves for the Spring treatment yields the same pattern at this time of the year.

Table 4 shows the amount of inorganic nitrogen as nitrate in parts per million found in the leachate on selected sampling dates. Also shown is the total amount of inorganic N in the leachate for each of these dates, computed by multiplying concentration by leachate volume. This calculation also includes any NH_4^+ that was present, which occurred in much smaller concentrations than NO_3^-.

Table 4. Concentrations of nitrate and total inorganic nitrogen (nitrate and ammonium) found in leachate of Spring and Fall treated lysimeters at HTRC during 1991.

Date	ppm N as NO_3^- Spring	ppm N as NO_3^- Fall	Total N kg/ha Spring	Total N kg/ha Fall
5/1	3.09		0.27	
6/12	2.97		0.44	
7/22	2.66		0.10	
8/17	1.30		0.11	
9/3	1.15		0.78	
10/22	n.d.[1]		0.03	
11/8	0.11	1.46	0.10	0.17
11/20	0.24	1.43	0.04	0.15
12/3	0.14	1.04	0.13	0.51
12/18	0.07	0.76	0.14	0.25
			2.14	1.08

[1] n.d. = below limits of detection.

The EPA has established 10 ppm N as nitrate in drinking water as the concentration above which humans should be concerned about possible health risks. Concentrations in leachate were well below that level at all sampling times. Total nitrogen collected in leachate on a surface area basis was equivalent to 0.04#N/M and 0.02#N/M for the Spring and Fall treatments, respectively. Because ^{15}N analyses have not been conducted yet, it is not known how much of the leached N was from applied fertilizer and how much was from other sources, such as decomposed organic matter. Although leachate N was low, it is still apparent from Figure 1 and Table 4 that the greatest potential for both water and nitrate loss through the profile occurs in the late Fall and Winter. More data on this subject will be collected in the Winter of 1992.

Data analysis to date has been limited. Analyses of plant N, organic N in soil, biomass N, and all ^{15}N analyses for 1991 samples are yet to be completed. The data presented here is preliminary, and has not been analyzed statistically. More complete data from this project will be forthcoming over the next several years, which will provide a basis for confidence in timing of N applications. This in turn should yield a nitrogen fertility program which promotes high quality turf while protecting the environment.